Metrolight Addressable Digital Lighting Interface (MADLI) Preliminary Overview.

Description:

Metrolight addressable digital lighting interface (MADLI) intended for electronic HID ballasts network control. Each ballast in the network has individual address and can be turned on, off, and dim through the network. Besides it each ballast can return own state, specific parameters as lamp voltage, lamp power, ballast temperature. Also some specific parameters can be set into the ballast. The network is a two-wire bus, to which all ballasts are connected in parallel.

Short specification:

- Maximum 1023 individual addressable ballasts within one system
- The ballast cannot act as a master controller
- Maximum 255 groups of ballasts
- Each ballast can be member of maximum 4 groups
- Asynchronous (UART-based) start-stop transmitting protocol
- Checksum error detection
- Baud rate 4800
- Allowed cable voltage drop: 2...3V
- No ground-loops because of isolation in the ballast
- Polarity insensitive interface input
- Overvoltage protection

Ballasts network can be driven from dimming module (with analog 0...10V input and potentiometer) that can turn on, off and dim all ballasts simultaneous or from the PC that connected to the ballast network through the control box.

PC software specification:

The PC application's main window can display several list view panels containing:

- A list of up to 1023 addressable ballasts, with names and addresses stored in a separate text file. For each item in the list there is a possibility to perform the following operations:

  - Selecting the item for further actions
  - Setting a new address for the selected ballast
  - Clearing the address of the selected ballast
  - Setting Group0...Group3 addresses for the selected ballast
  - Reading and writing of the ballast EEPROM parameter values, stored in a separate text file
  - Adding ballasts to new or existing groups with the ability to drag and drop items.

- A list of up to 255 ballast groups, with names and addresses stored in multiple text files. For each item in the list there is a possibility to perform the following operations:

  - Creating the new group and setting its name and address
  - Selecting the item for further actions
  - Changing the selected group address
  - Renaming and deleting items

- A list of ballasts owned by the selected group with the ability to select the item and perform all the ballast actions specified above.

- A list of the selected ballast parameters stored in a separate text file with the ability to display various numbers of parameters and different parameter types depending on the selected ballast address. This list should support reading and automatic updating of the specified parameters values, which are to be displayed in table fields along with the current ballast state. Besides, the parameter values should be displayed on graphical meter-like indicators.

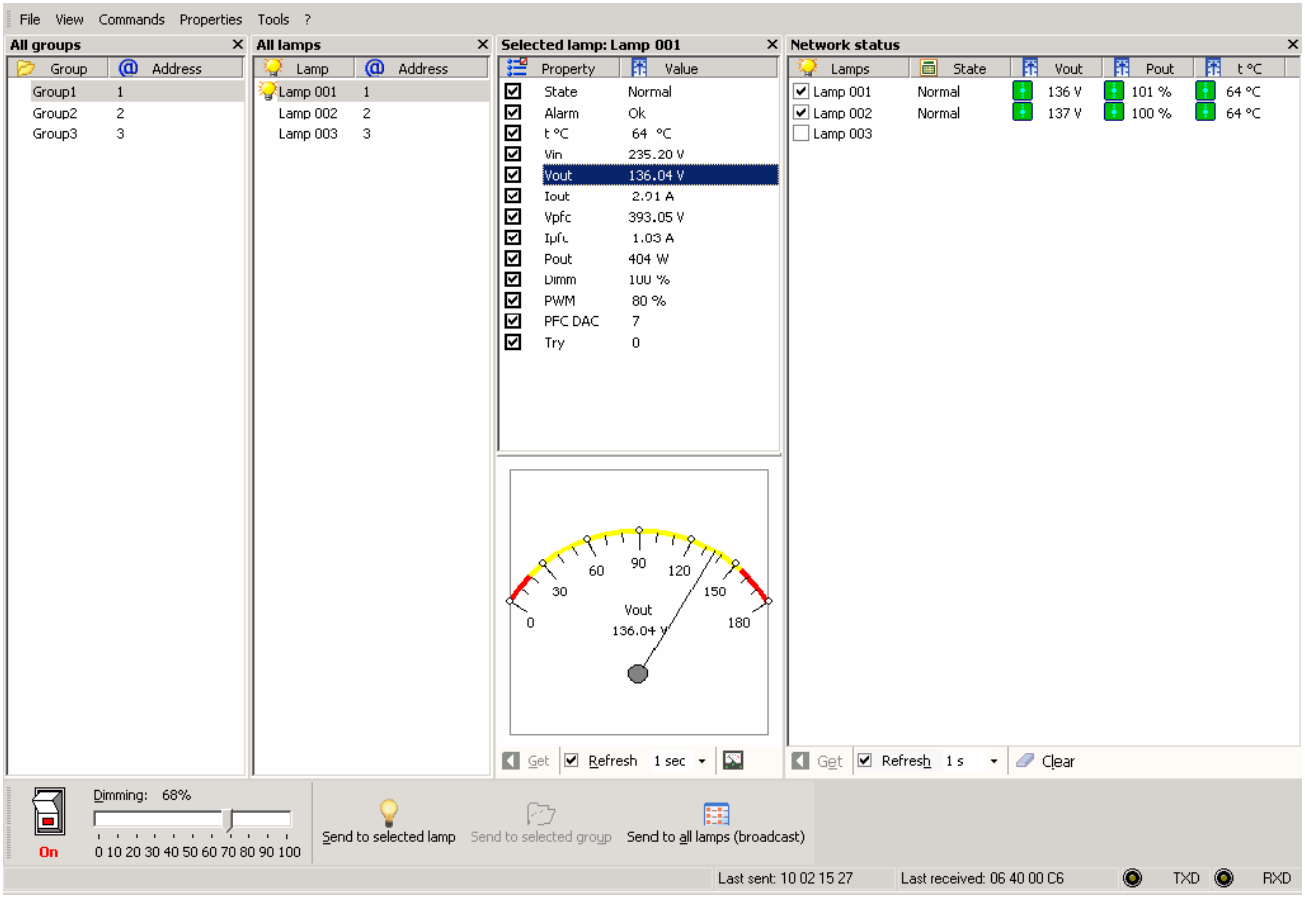

Figure 1.

The application display table views of all network ballasts' states and parameters specified in a separate text file. This table also supports reading and automatic updating of all parameters values, which are to be displayed in table fields along with the current ballasts' states.

The application support ON/OFF/DIMMING commands for the selected ballast, selected group of ballasts and for all network ballasts (broadcast commands).

The application support schedule file that allows sending commands ON/OFF/DIMMING commands for the selected ballast, selected group of ballasts and for all network ballasts (broadcast commands) on specified date and time.

The application support logging to the log file.

In addition, the application should provide functions to read network configuration, store the received network configuration data on disk, and write network configuration back to network using the previously stored data.

Connection diagram:

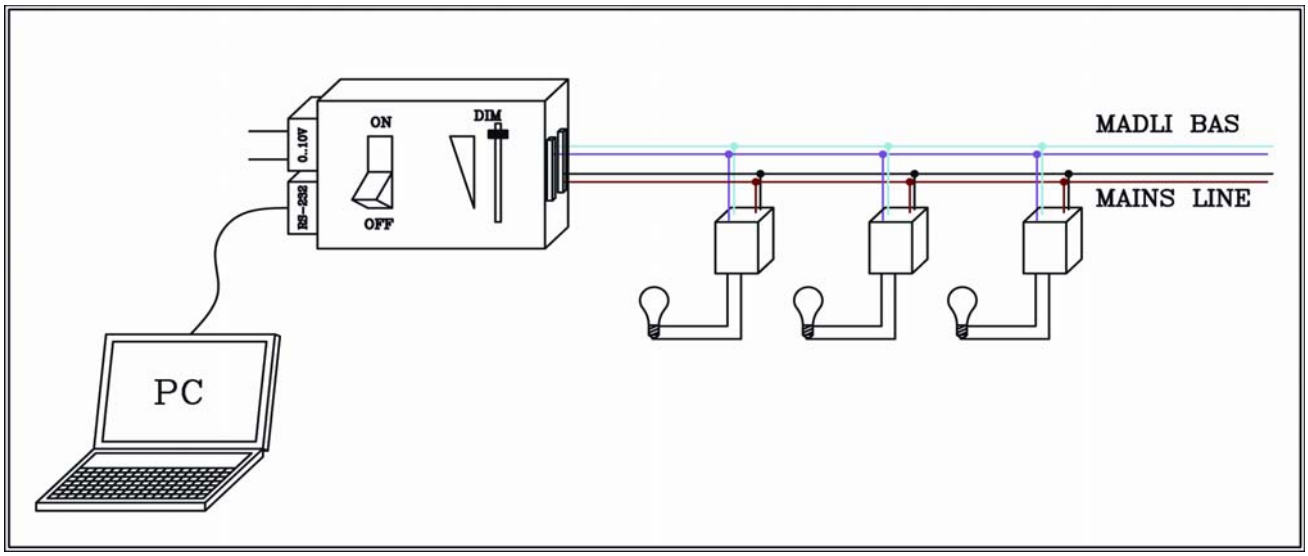

Figure 2.

Voltage rating

The signal levels specified in Figure 1 are considered to be reasonable for reliable operation of electronic ballast over the specified operating temperature of the ballast.

In general the interface voltage is high if there is no communication (idle state).

The voltage range shall be between 9.5 V and 22.5V for **"high level"** AND BETWEEN –6.5V and +6.5V for **"low level"** respectively. Between 6.5V and 9.5V the level is undefined.

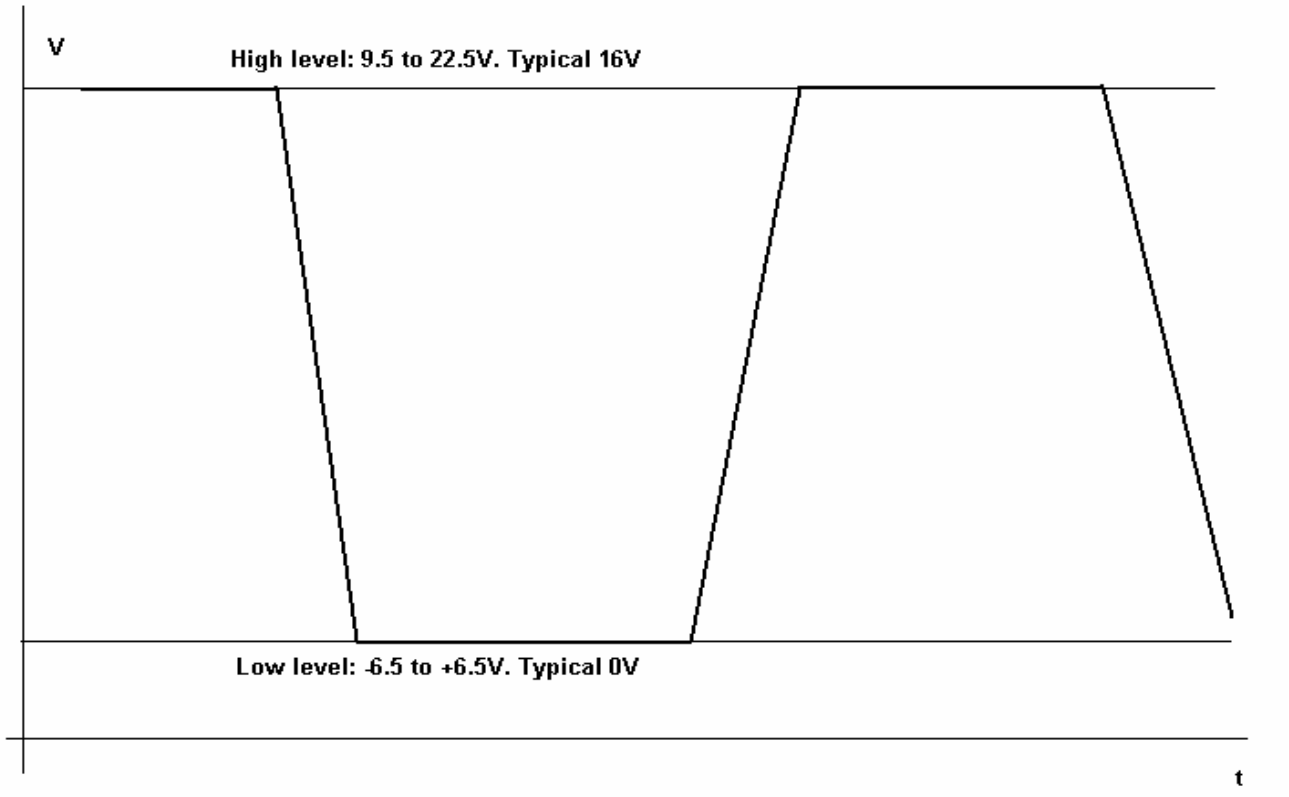

Figure 3.

Current rating

In non-active state the ballast shall not exceed 2mA @ ≤22.5V because of the actual maximum number of ballasts per control unit.

The ballast shall be able to sink at least 250mA under all circumstances.

The interface specifications at the ballast terminal shall be:

Active state: low voltage level ≤ 4.5V; high current level ≤ 250mA (limited by the power supply).
Non-active state: high voltage level ≤ 22.5V, low voltage level ≤6.5V; high current ≤ 2mA.

Interface circuit diagram

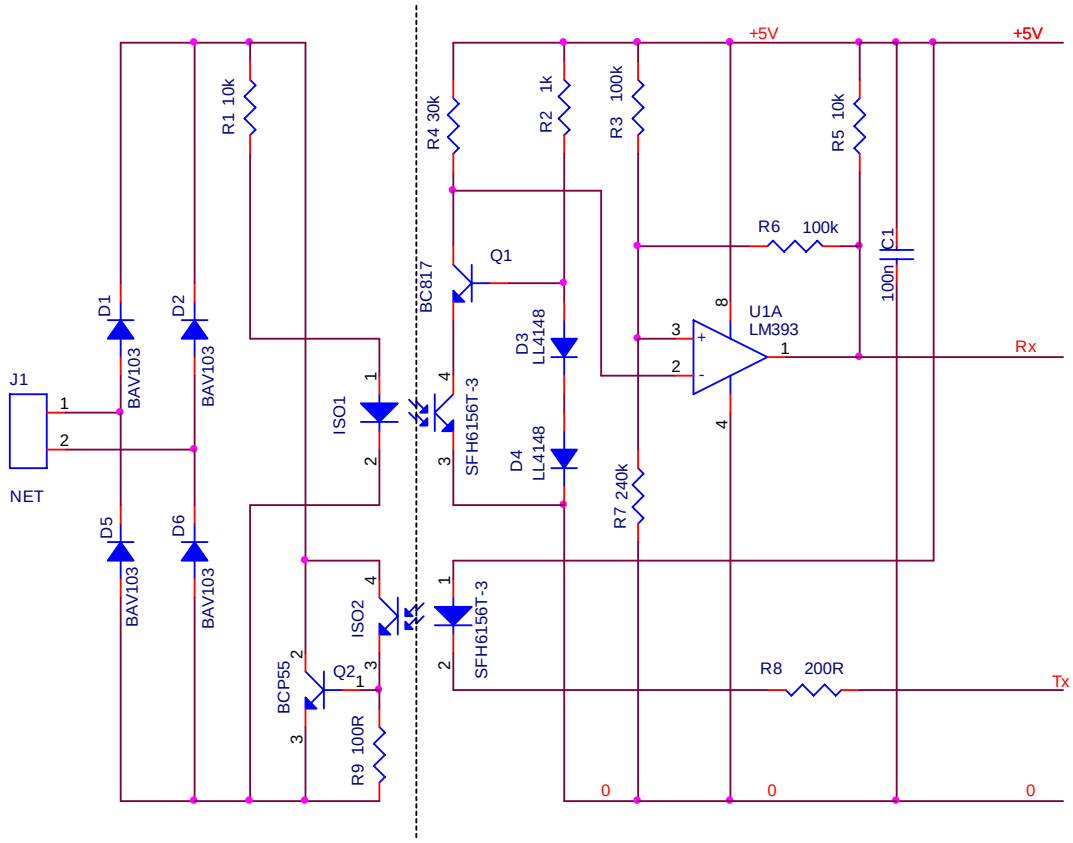

Figure 4. Ballast network interface. Circuit diagram.

Design tips.

- ✓ Optocoupler output current amplification with Q2 in the transmitter.
- ✓ Minimum voltage threshold with Zener diode D1.
- ✓ Thermal stabilization and high sensitivity (low input current) with dynamic load Q1 for the optotransistor ISO1.

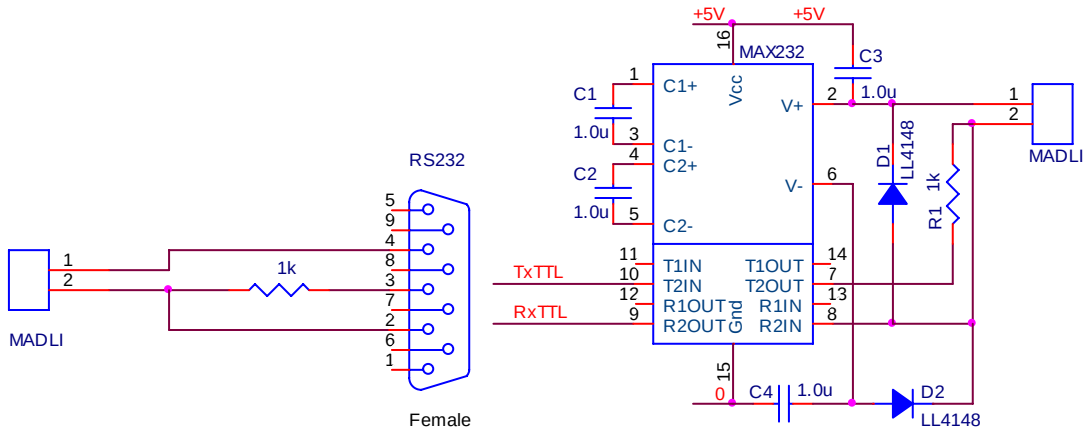

Figure 5. Simple PC to Ballast and TTL UART to Ballast interface. Circuit diagram.

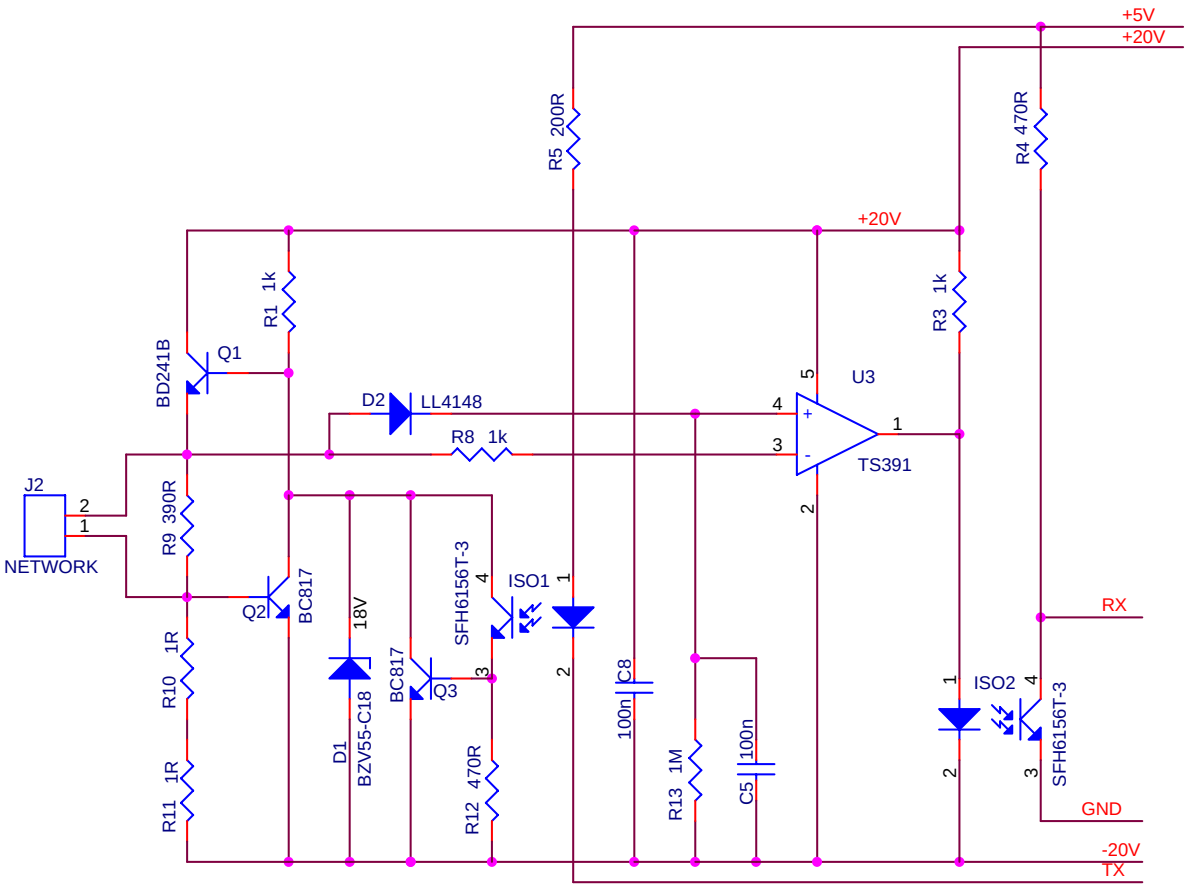

Figure 5. Control unit network interface. Circuit diagram.

Design tips.

- ✓ Q1, Q2, D1 - parametric voltage regulator with current limit (depends of the shunt resistance R10, R11).
- ✓ ISO1, Q3 – reference manipulator for voltage regulator.
- ✓ Comparator U3 – high sensitive following line voltage sensor.

Protocol description

For the transmitter and receiver (from and to ballast) uses standard UART. Protocol based on the packets of the bytes. Each packet has the checksum for error protection. Packet from the control unit (master) has address and data. Packet from the ballast (slave) has only data bytes. Master can send individual, group and broadcast packets (messages) in to the line. Slave gives answer only on the individual messages if address in the master message is the same with slave address. New ballast has not individual and group address and can react only on broadcast messages. Address can be programmed through the same network interface but without network (ballast should be alone) otherwise the same address will be written to the all devices that will cause to the conflict in the network.

To the ballast (Master)

	Bit/Byte	7	6	5	4	3	2	1	0
Command/Addr	**0**	CM4	CM3	CM2	CM1	CM0	Group	A9	A8
Addr/Group	**1**	**A7**	**A6**	**A5**	**A4**	**A3**	**A2**	**A1**	**A0**
Data	**2**	D7	D6	D5	D4	D3	D2	D1	D0
CheckSum	**3**	**0**	CS6	CS5	CS4	CS3	CS2	CS1	CS0

From the ballast (Slave)

	Bit/Byte	7	6	5	4	3	2	1	0
State	**0**	ST7	ST6	ST5	ST4	ST3	ST2	ST1	ST0
Data 0	**1**	D7	D6	D5	D4	D3	D2	D1	D0
Data 1	**2**	D7	D6	D5	D4	D3	D2	D1	D0
CheckSum	**3**	**1**	CS6	CS5	CS4	CS3	CS2	CS1	CS0

Commands

Command	Description	Comment
0	**On**[Dimm]@addr	*Note 1, Note 4.*
1	**Off**[Dimm]@addr	*Note 1, Note 4.*
2	**GetRam**[ram_addr]@addr	*Note 3.*
3	**GetEE**[ee_addr]@addr	*Note 3.*
4	**SetAddr**[0x55]@addr	*Note 2.* Set ballast address
5	**SetGrp0**[gr_addr]@addr	*Note 1.*
6	**SetGrp1**[gr_addr]@addr	*Note 1.*
7	**SetGrp2**[gr_addr]@addr	*Note 1.*
8	**SetGrp3**[gr_addr]@addr	*Note 1.*
9	**Lock**[0x55/0xAA]@addr	*Note 1*, 0xAA - Unlock EEPROM modification
10	**WriteAddr**[0x55]@addr	*Note 1.* Write addr to EEPROM
11	**SetEEAddr**[ee_addr]@addr	*Note 1.*
12	**Set EEData**[ee_data]@addr	*Note 1, Note 5.*
13	**Test**[Dimm]@addr	*Note 1, Note 4.*
14	**Prefix**	For future extension
15	RESERVED	
16	RESERVED	
17	RESERVED	
18	RESERVED	
19	RESERVED	
20	RESERVED	
21	RESERVED	
22	RESERVED	
23	RESERVED	
24	RESERVED	
25	RESERVED	
26	RESERVED	
27	RESERVED	
28	RESERVED	
29	RESERVED	
30	RESERVED	
31	RESERVED	
32	RESERVED	

Note 1. *Commands **On**[dimm]@addr, **Off**[dimm]@addr, **SetGroupN**[gr_addr]@addr, **Lock**[0x55/0xaa]@addr, **WriteAddr**[0x55]@addr, **SetEEAddr**[ee_addr]@addr, **SetEEData**[ee_data]@addr returns ballast state if address is the same as ballast address. If address is broadcast (1023) or broadcast group or group address of the ballast command return nothing but ballast react on it. If time between commands **SetEEAddr** and **SetEEData** more than 100ms command **SetEEData** do nothing. After 10s after **Lock**[0xaa]@addr command sending ballast automatic lock EEPROM. Commands **SetGroupN**[gr_addr]@addr returns group address in the **Data 1** field. Host can compare this **Data1** field with stored data and check if operation was successes.*

Note 2. *Command **SetAddr**[0x55]@addr returns nothing. If time between commands **SetAddr** and **WriteAddr** more than 100ms command **WriteAddr** do nothing.*

Note 3. *Commands **GetRam**[ram_addr]@addr and **GetEE**[ee_addr]@addr returns requested values if address is the same as ballast address or 1023 (broadcast). Group address ignores for this commands. Broadcast address (1023) used only during setup when ballast is not on the network and works alone.*

Note 4. *Commands **On**[dimm]@add and **Off**[dimm]@addr sends twice with less than 100ms delay. Otherwise ballast ignores these commands. Optimal delay is 70ms.*

Note 5. *Command **SetEEData**[ee_data]@addr return ballast state in the **State** field of the returned packet, time to automatic lock **EEPROM** in the **Data 0** field (in 100ms units) and actual data from the **EEPROM** in the **Data 1** field. Host can compare this **Data1** field with stored data and check if operation was successes.*

RAM Map

Ram_addr	Description	Comment
0	Dimming	Dimming level
1	GROUP 0	Group 0 address
2	GROUP 1	Group 1 address
3	GROUP 2	Group 2 address
4	GROUP 3	Group 3 address
5	MINUTES	0 ... 119
6	2_HOURS	2 ... 131070
7	COUNTER	0 ... 65535
8	VERSION	* 100
9	ADDRESS	Own address
10	ID0	0 ... 65535
11	ID1	0 ... 65535
12	ID2	0 ... 65535
13	Reserved	
14	Reserved	
15	Reserved	
16	Param 0	See parameters map.
…		
255		

Master message description

If the **Group** bit is set to 1, the **A0**-**A7** is address of the group. If the **Group** bit is cleared to 0, **A0**-**A9** is address of the ballast. **CM0**-**CM4** is a command. The **D0**-**D7** bits are parameter of the command. **CS0**-**CS6** are 6 bits of the checksum. Higher bit (MSB) of the checksum is cleared to 0 and indicates the master message.

All set to 1 bit in the address is the broadcast message (for all ballasts or all groups). The ballast answers only on the commands, addressed to it. On the group and broadcast messages ballast does not answer.

The command **SetAddr**[0x55]@addr is sending when ballast not in the network, and connected to the control unit.

Slave message description

The ballast answers (if answers) own status. A part bit under State, part under Alarm - is a matter of fact is two numbers describing a condition of the ballast. In the data fields there is requested parameters (used only one field, second for extensions). In CS0-CS6 - 6 bits of the check total, it higher bit is set to 1 and indicate the slave message (answer). Other ballasts receive this message but ignore it.

The pause between the sending and beginning of the answer is equal about time of transfer of a 1.5 byte. If during this time there is no answer it signifies already and will not be. It means that there is communication error, or this ballast burn down/disconnect.

Dimming related parameters

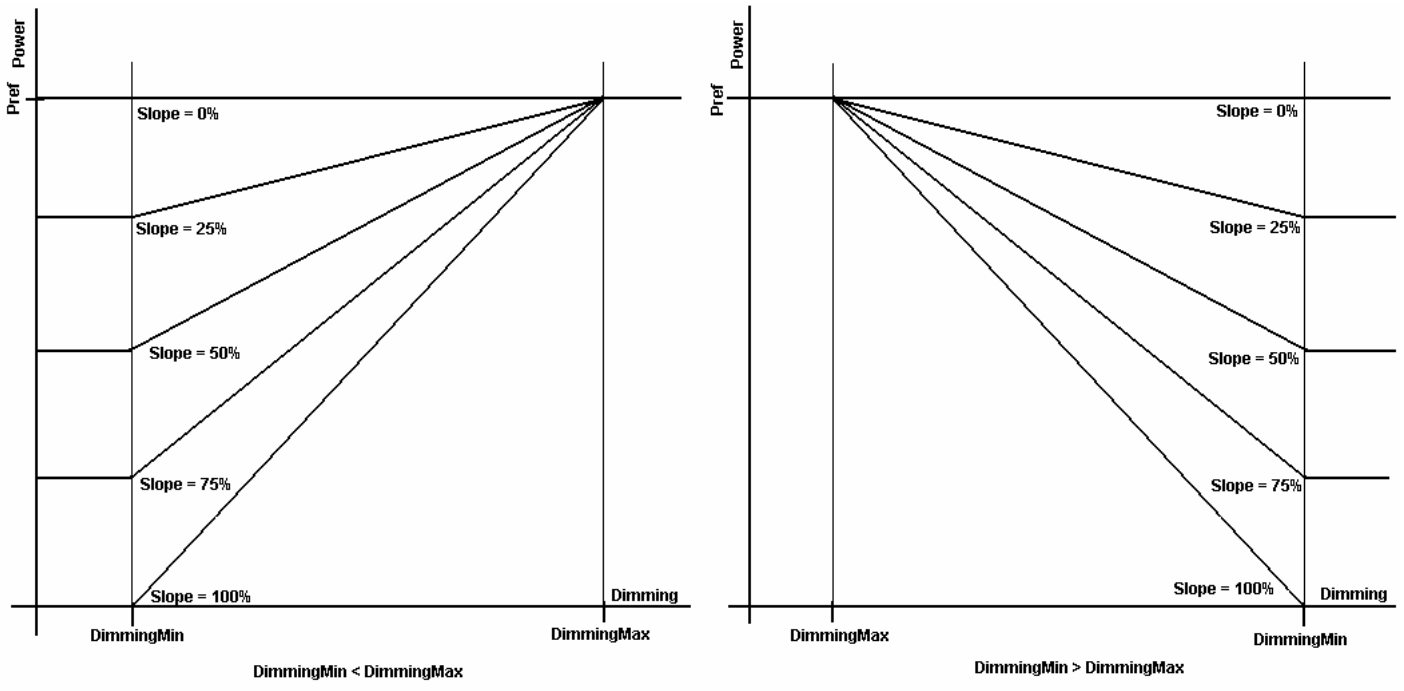

Figure 6. Dimming related parameters.

Appendix 1.

MEB400HF parameters description

State bits description

ST7...ST4	Alarm
0	Ok
1	Not Ignite
2	Overtemperature
3	Vout High
4	Vout Low
5	PFC Low
6	PFC High
7	Switch Off
8	Short load
9	No load
10	Vin Low
11	Vin Off
12	
13	
14	
15	

ST3...ST0	State
0	Off
1	Not ignite
2	Wait
3	On
4	Ignition
5	Warm-up
6	Normal
7	
8	
9	
10	
11	
12	
13	
14	
15	

MEB 400HF RAM (parameters) Map

Ram addr	Name	Multiplier	Unit	Description
0	DDim	0.39215	%	Dimming level
16	Vin	2.1	V	Input (mains) voltage
17	Vout	0.958	V	Output (lamp) voltage
18	Ipfc	0.0052	A	PFC current
19	Vpfc	3.046875	V	PFC voltage
20	Pout	4	W	Output (lamp) power
21	t °C	1	°C	Ballast temperature
22	Pref	4	W	Power reference
23	Try	1	-	Ignitions tries
24	PFC DAC	1	-	PFC DAC reference
25	PWM	0.39215	%	Lamp current reference
26	Iout	0.032	A	Output (lamp) current
27	ADim	0.55555	%	Analog dimming level
28	Pref Dim	4	W	Actual power reference
29	Tmax	1	°C	Max reached temperature

MEB 400HF EE Map

EE addr	Name	Multiplier	Unit	Description
0	Power reference	4.0	W	
1	Power adjustment	0.78125	%	
2	Ignition time	0.1	s	
3	Regulator time constant	1	ms	
4	Restart period	1	s	
5	Short load detection time	0.1	s	
6	State			Stored state (On/Off)
7	Vpfc adjustment	0.78125	%	
8	Warmup current	0.032	A	
9	Iignition output current limit	0.032	A	
10	Vin adjustment	0.78125	%	
11	Iout adjustment	0.78125	%	
12	Termo adjustment	0.78125	%	
13	Ipfc adjustment	0.78125	%	
14	Fade up step	0.1	s	
15	Fade down step	0.1	s	
16	Modulation deep	0.8	%	
17	Vout off max	0.958	V	Lamp End Of Life max level
18	Vout off min	0.958	V	Lamp End Of Life min level
19	Lamp minutes	1		0 ... 119
20	Lamp 2 hours Lo	1		
21	Lamp 2 hours Hi	1		
22	Lamp counter Lo	1		
23	Lamp counter Hi	1		
24	T derating	1	°C	Power derating threshold
25	T off	1	°C	Thermal protection off level
26	T on	1	°C	Thermal protection on level
27	Ignition PFC current limit	0.0052	A	
28	Ignition PFC sweep reset current	0.0052	A	
29	Ignition PFC protection current	0.0052	A	
30	Vin derating	2.1	V	Power derating threshold
31	Vin off	2.1	V	Vin protection level
32	Tmax	1	°C	Max operating temperature
33	Delay to dimming	1	min	For lamp stibilization
34	Dimming slope	0.39216	%	See Figure 5.
35	DimmMax	1		0...255. See Figure 5.
36	DimmMin	1		0...255. See Figure 5.
37	Moving sensor delay	1	min	Delay for moving sensor
38	Config	1		Configuration byte

Config.0 = 1 – switch to wireless protocol modification (without doubling On/Off commands).
Config.1 = 1 – switch on scheduler.

Appendix 2.

MEB400S parameters description

State bits description

ST7...ST4	Alarm
0	Ok
1	PFC High
2	PFC Low
3	Cap mode
4	End of life
5	Switch Off
6	Overtemperature
7	Extinguish
8	Vin low
9	Error
10	
11	
12	
13	
14	
15	

ST3...ST0	State
0	Off
1	Not ignite
2	Start
3	On
4	Cap test
5	Ignition
6	Warm-up
7	Normal
8	
9	
10	
11	
12	
13	
14	
15	

MEB 400S RAM (parameters) Map

Ram addr	Name	Multiplier	Unit	Description
0	DDim	0.39215	%	Dimming level
16	Vin	2.06	V	Input (mains) voltage
18	Ipfc	0.0064	A	PFC current
19	Vpfc	3.046875	V	PFC voltage
20	Pout	2.45	W	Output (lamp) power
21	t °C	1	°C	Ballast temperature
22	Pref	2.45	W	Power reference
23	Try	1	-	Ignitions tries
24	PWM	0.39215	%	VCO reference
25	ADim	0.39216	%	Analog dimming level
26				
27				

MEB 400S EE Map

EE addr	Name	Multiplier	Unit	Description
0	Power reference	2.45	W	
1	Power adjustment	0.78125	%	
2	PWM adjustment	0.39216	%	
3	Ignition time	1	ms	
4	Regulator time constant	1	ms	
5	Restart period	1	s	
6	Iignn limit	6.4	mA	
7	Icap limit	6.4	mA	
8	Ipfc ign	6.4	mA	
9	Vin adjustment	0.78125	%	
10	Vpfc adjustment	0.78125	%	
11	Ipfc adjustment	0.78125	%	
12	Termo adjustment	0.78125	%	
13	Adimming adjustment	0.78125	%	
14	T derating	1	°C	Thermal derating threshold
15	T off	1	°C	Thermal protection off level
16	T on	1	°C	Thermal protection on level
17	Vin derating	2.06	V	Power derating threshold
18	Vin off	2.06	V	Vin protection level
19	Dimming slope	0.39216	%	See Figure 5.
20	Dimming max	0.039216	V	0...10V See Figure 5.
21	Dimming min	0.039216	V	0...10V See Figure 5.
22	Delay to dimming	1	min	For lamp stabilization
23	Fade up step	100	ms	
24	Fade down step	100	ms	
25	Tmax	1	°C	Max reached temperature
26	Ign time limit	1	min	
27	PWM Start	0.39216	%	
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40	Lamp minutes	1		0 ... 119
41	Lamp 2 hours Lo	1		
42	Lamp 2 hours Hi	1		
43	Lamp counter Lo	1		
44	Lamp counter Hi	1		

Appendix 3.

MEB 1000HF parameters description

State bits description

ST7...ST4	Alarm
0	Ok
1	PFC High
2	PFC Low
3	Cap mode
4	Switch Off
5	Overtemperature
6	Extinguish
7	Vin low
8	Error
9	
10	
11	
12	
13	
14	
15	

ST3...ST0	State
0	Off
1	Not ignite
2	Start
3	On
4	Cap test
5	Ignition
6	Warm-up
7	Normal
8	
9	
10	
11	
12	
13	
14	
15	

MEB 1000HF RAM (parameters) Map

Ram addr	Name	Multiplier	Unit	Description
0	DDim	0.39215	%	Dimming level
16	Vin	2.0	V	Input (mains) voltage
17	ADimm	1	-	Analog dimming
18	Ipfc	0.0065359	A	PFC current
19	Vpfc	3.27	V	PFC voltage
20	Pout	4.65	W	Output (lamp) power
21	Vout	1.362	V	Lamp voltage
22	t °C	1	°C	Ballast temperature
23	Pref	4.65	W	Actual power reference
24	Try	1	-	Ignitions tryes
25	PWM	0.39215	%	VCO reference
26	Iout	0.0266	A	Lamp current
27	Pref dimm	4.65	W	Actual power reference
28	Tmax	1	°C	Max reached temperature
29	Time, s	1	s	Seconds from start
30	Time, min	1	min	Minutes from start

MEB 1000HF EE Map

EE addr	Name	Multiplier	Unit	Description
0	Power reference	4.65	W	
1	Power adjustment	0.78125	%	
2	PWM init reference	0.39216	%	Warmup state
3	Ignition time	1	ms	
4	Regulator time constant	1	ms	
5	Restart period	1	s	
6	Iignn limit	0.0065359	A	
7	Icap limit	0.0065359	A	
8	Ipfc ign	0.0065359	A	
9	Vin adjustment	0.78125	%	
10	Vpfc adjustment	0.78125	%	
11	Ipfc adjustment	0.78125	%	
12	Termo adjustment	0.78125	%	
13	Iout adjustment	0.78125	%	
14	T derating	1	°C	Thermal derating threshold
15	T off	1	°C	Thermal protection off level
16	T on	1	°C	Thermal protection on level
17	Vin derating	2.0	V	Power derating threshold
18	Vin off	2.0	V	Vin protection level
19	Dimming slope	0.39216	%	See Figure 5.
20	Dimming max	1	-	0...255 See Figure 5.
21	Dimming min	1	-	0...255 See Figure 5.
22	Delay to dimming	1	min	For lamp stabilization
23	Fade up step	100	ms	
24	Fade down step	100	ms	
25	Tmax	1	°C	Max reached temperature
26	Ignition time limit	1	min	
27	Vout max off	1.362	V	Lamp end of life
28	Vout min off	1.362	V	Lamp end of life
29	Ipfc extinguish	0.0065359	A	
30	Warmup current	0.0266	A	
...				
40	Lamp minutes	1		0 ... 119
41	Lamp 2 hours Lo	1		
42	Lamp 2 hours Hi	1		
43	Lamp counter Lo	1		
44	Lamp counter Hi	1		